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desirable to provide as far as possible within each main subject of study some course which had to do with the relationship of that special study to the larger human problems of which we have been speaking. I take it that this is what Professor Woodbridge had in mind at the recent meeting of the Philosophical Association when he said that what philosophy needed above all things was not more discussion of what philosophy should be or do, but fruitful work at those concrete problems which meet us on every hand and which clamor for solution. But whatever the method followed in detail, the main thing to be aimed at should be that the men who in their different fields are working out the big human problems should be brought together so that their minds should be fructified by contact and the bearing of the work of each be seen in its relation to that of all the rest.

This would require, no doubt, a radical change in present university policy and ideals. It would mean the breaking down of the hard and fast line of partition between the different departments and the abandonment of the conception of a discipline as a vested right, which is the most unfortunate of all our legacies from the German educational system. But what is philosophy for if not to break down barriers and reveal hidden unities. Organization is after all only a by-product. All beginnings take place in the mind, and if only the philosophers conceived their work in a large enough way there is nothing in the world of practice which they might not ultimately hope to accomplish. They might even work that miracle of miracles of making the university again a place where reflective thought about the ultimate problems should be regarded as the most important work that a man could do, and mind meet mind in common quest of life's supreme values.

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THE VALUE OF THEORIES

THE human mind is an incorrigible maker of fiction, whether it be in science or poetry. Theories have always sprung as spontaneously from man's imagination as have fairy tales. Indeed the myths of primitive races are at once theories and fairy tales. But to the sophisticated scientific consciousness, proving a theory is very different from painting a skilful and elaborate imaginative picture. If a theory is a fiction, it is at least a rational fiction as remarkable for its adherence to facts as for its departure from them.

The aim of theorizing is usually thought to be the discovery of truth—truth about the inner relations and structure of the natural world. A scientific fairy tale must be true, or at worst highly probable. Its truth, or probability, is reached by inductive inferences from the facts of experience as they appear in every-day life or in laboratories. Such is the ordinary statement of the logicians.

Is this account of the proof of the truth, or probability, of theories by a peculiar method of reasoning—the inductive method—adequate? A closer study of what a theory is, of how it is related to fact, and of what human interests it fulfills, suggests a different conclusion. The truth of a theory is its least important value; the proof of its truth, or even of its probability, is doubtful; and the peculiar method of reasoning known as induction is not at all a distinct type of logical process; it reduces wholly to deduction.

We state our conclusions first, and shall elaborate them by an analysis of the elements which give value to any theory, which make it a *good* theory.

Theorizing is at once a practical and a fine art. A theory is a useful tool by means of which man can mold nature to his will. It is also an intellectual object with a beauty and a value peculiarly its own. Like a poem or a painting, it seeks more than the transcription of fact. It is a reflective effort to see beneath the surface.

Theories share beauty with the products of the fine arts. The elegance of a body of scientific propositions, its orderliness, simplicity and completeness are a kind of beauty in the abstract. The system can be grasped, as is a work of art, in a single mental intuition. The praise of the beauty of ideas goes back to Plato, and in modern thought pours fervently through the essays of Mr. Bertrand Russell. Esthetic values appear both in the mathematical and physical sciences, and are a bond of union between them.

The pragmatists have directed attention to the utility of theories. But this is the sole element of value which they have found in them. It is perhaps the least fundamental. The purely intellectual interest which compels men to theorize is largely detached and disinterested. It is like Spinoza's intellectual love of God, where God is the whole spectacle of existence. The usefulness of theories is secondary and derived. Their primary value is the satisfaction they give to that " independent hunger of the mind " which is curiosity.

Hence the value *par excellence* which distinguishes theorizing from the fine and the practical arts is something other than utility or beauty. Theories explain. A theory goes behind the given fact to build a scheme in which the given fact will fit, and by the aid of which it will be understood. Theories make experience intelligible.

A good theory *may* have utility and beauty; it *must* have explanatory value.

We may ask, then, what makes a theory an explanation? On this question the whole discussion will hinge.

A theory takes on explanatory value when it is linked to fact by its logical consequences. To explain is to deduce. Man has a predilection for deduction; the essence of rationalization is the construction of deductive systems. To have deduced a proposition from some other proposition known to be true gives a strange satisfaction to the inquiring mind; and when a theory yields this satisfaction it is intellectually valuable. Conversely, if a theory has no true consequences it has no explanatory value. It is then a figment of the imagination, a veritable fairy tale with a doubtful title to existence.

The search for antecedents and consequences goes on wherever thought goes on. In the mathematical and physical sciences the process is essentially the same; and everywhere antecedents have or have not explanatory value according as they have or have not true consequences.

Paradoxical as it may seem, it is only true propositions which demand explanations. A false proposition is disposed of once and forever. But a true proposition stands as a challenge before the knower with the question, "Why am I what I am?" Science begins with fact, with true propositions about fact. From what is known here and now it extends its theoretical picture into the uttermost realms of space and time and beyond the sensory threshold of the most delicate perceptions and sensitive instruments. The known is explained in terms of the unknown. The hypothetical becomes the ground from which the actual is deduced.

Generalization is the first and most natural step toward theory. Indeed a generalization is a kind of elementary theory, since it is hypothetical. It is the premise of a small deductive system. Like all hypotheses a generalization is (1) never completely verifiable, and (2) it yields deductive consequences. If *all* objects of a certain class behave in a certain manner it follows that any particular object of the class which appears in experience will behave in this manner. So long as this deductive consequence is true, the generalization will have explanatory value; but if the consequence is false, if there are exceptions to the law or the generalization, it will cease to be valuable. It must then be corrected.

Since all the objects of the class to which the generalization applies do not appear in experience, the generalization is an imaginative construction. It goes behind and beyond experience. It is not a description of any entity which is wholly known. We can point only in imagination to *all* living creatures or to *all* chemical substances.

A usual kind of explanation is causal explanation. The cause is that from which the effect can be deduced. At first the cause may not be thought of as the logical antecedent of the effect, but merely as its temporal antecedent. The naïve philosophy of causation assumes that because *A* precedes *B* and is temporally contiguous to it, *A* therefore causes and explains *B*. But a temporal antecedent is quickly generalized into a logical antecedent, and this gives rise to a less naïve explanation. *A* can cause *B* only if *A* uniformly precedes *B;* only if it is an invariable antecedent of *B*. So that the causal connection becomes a logical connection—if *A,* then *B*—in which the notions of temporal succession and contiguity are secondary. The one event becomes an explanation of the other because the interest in deducing one from the other is satisfied.

But the paradise of the theorist lies beyond generalization and natural law. He has yet to create a deductive system into which his generalizations and natural laws will fit as consequences. Simple generalizations and empirical natural laws have so little of the element of theory in them that they are usually thought of as fact rather than theory. They are the mere beginnings of explanation, the raw materials of the wider structures which are theories proper. To the "why" the answer is always "why." The theorist now aims at relating laws to one another, at unifying systems by deducing them in a body from more primitive and inclusive premises. And this leads him into the thin world of conception and assumption, where the scientific imagination finds itself most free. Since deductions can always be made in a great variety of ways and from a large number of different premises, the scope for human ingenuity in inventing deductive unifications in any scientific field is unlimited.

Hence, in the realm of pure theory, the problem of evaluating theories will have a double aspect. The scientist will ask himself not only what possible explanations can I offer, but what is the best of all possible explanations? And so, to the criterion of value in theories—that the theory yields true deductive consequences—we must add a criterion of relative value. This will be the completeness or incompleteness of these consequences. The elegance and simplicity, of which we spoke as esthetic values, will be secondary criteria of relative value.

The completeness of a theory is its capacity to give by deduction all the particular and general propositions in a widely extended field of knowledge. The theory which explains all is better than the theory which explains only a part. The Newtonian mechanics, for instance, allows the deduction from a few premises not only of Kepler's laws of the motions of the planets and Galileo's laws of falling bodies, but also a complete set of mechanical theorems which on other non-deductive evidence are believed to be true. For this reason the Newtonian theory is of the highest value. But the explanatory value of the mechanics of Einstein is perhaps even greater. It is a completer theory. Whereas Newton restricts himself to motions whose coördinates are fixed, Einstein considers motions whose coördinates are themselves in motion in every conceivable way, and finds "that the laws of physics are independent of any conventional system of coördinates, but can be expressed truly in all."[1] Einstein's theory is completer and more valuable than Newton's for another reason. "By combining the principle of the relativity of motion with the principle of the absolute constancy of the velocity of light, Einstein was able to achieve the highest technical triumph for which all the physicists of the past had sought in vain, to wit, unification of the whole of physics. The attempts to unify physics by deriving the laws of electricity and optics from those of mechanics had definitely failed, and the converse efforts to explain the fundamental facts of mechanics such as inertia on the basis of electricity were not universally satisfactory. Einstein achieved the unity of mechanics and electricity, the two divergent branches of physics, by subordinating both to the same group of transformations and showing these transformations to have the highest heuristic value in both branches."[2]

We shall not belabor the point by illustration. The test of value in theories is everywhere the same—do they yield true consequences? And the better theories are always those which are the most complete. This is true equally of theories of society and theories of the structure of matter; it holds in political economy as well as in astronomy.

The deductive systems of mathematics and logic are also, from some aspects, explanatory theories. Modern analyses lead us to believe that the relation of a logical or mathematical system to the facts of experience is not important. From certain primitive ideas and primitive propositions—postulates, we may call them—deductions are drawn. The primitive ideas and propositions are chosen for reasons of convenience and elegance in exposition; they need not be true; the question of their truth is beside the point. They need only be simple, independent and consistent. And the theorems deduced from them need have no application to the world of our experience. They are commonly said to be merely possibilities; and the procedure by which they are reached is a method of exploring the realm of possibilities. But a deductive system which purports to be a system of logic, of geometry or algebra—which, in short, purports to be anything other than a pure deductive system with no application—does have among its consequences a large number of propositions which we believe to be true quite apart from their place in the system. Thus, a system of logic will somewhere state, either as postulate or theorem, the law of contradiction; a system of Euclidian geometry will include the proposition that parallel lines do not intersect; a system of algebra the rules of multiplication and addition. The knowledge of algebra, geometry and logic which comes to us in experience does embrace these propositions; they appear to be facts in our experiential world. We are not in need of any logical or geometrical or algebraic theory to convince us of their truth. But we are in need of rationalizing them, or fitting them into a system; in short, of explaining them.

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[1] Morris Cohen, "Some Philosophic Aspects of the Principal of Relativity," a paper read before The American Philosophical Association meeting in New York, December, 1920.

[2] *Ibid.*

Those deductive systems of mathematics and logic whose aim is to analyze certain generally accepted mathematical or logical truths by deducing them from simple, consistent and independent postulates, are explanatory theories. Those mathematical and logical systems which have no factual interpretations, which remain within the realm of the possible without touching the actual, are not explanatory. Their consequences as well as their premises belong to the imagination. Nowhere have they a foot upon the earth. There is nowhere in them a proposition which we can know to be true in fact, hence there is nothing to be explained.

So we may say there exist explanatory and non-explanatory deductive systems. The physical sciences build explanatory deductive systems. The mathematical sciences build both explanatory and non-explanatory systems. But there is no vast gap between the method of physics and mathematics, as those who oppose inductive to deductive logic suppose.

It is well enough to speak of explanatory value, of utility and elegance; but, it will be asked, what of the truth of these theories? The single indispensable value of any theory, it will be said, is truth. An untrue explanation is worse than none. This truth, which is so frequently demanded of theories, is of a rigid kind—logical inferability from true premises. The principle of induction, for which many philosophers have sought in vain, is supposed to assure it.

The difficulty in proving the truth of theories arises from two sources, (1) their generality, and (2) the use of non-empirical entities as terms in them. If theories were not general, if they did not intend to apply to all cases, future and past, near and remote, and to all possible experiences, we might verify them immediately within the finite life of the race. But to confine a theory, to restrict its generality, is to impair its completeness, and hence to lessen its value. Yet the facts on which a theory is built are always particular. The problem of how to pass from a restricted to an unrestricted area, from " some " to " all," has been the classic difficulty of inductive logic. Even if this problem were solved, the other would remain. Non-empirical terms figure importantly in many of the best theories. The world of atoms and of luminiferous ether is quite beyond experience. If we are to prove that propositions about such entities are true, and if we are to establish theories in their total generality, we must resort to something less direct than an appeal to experience.

The answer is inference. We must *infer* the truth of our theories. The failing prop of inductive inferences has been the principle of the uniformity of nature, variously named the principle of causality and the principle of sufficient reason. As applied to the passage from " some " to " all " the principle may be stated thus: every particular proposition can be so qualified that it can be truly generalized. Now, if this were so, we should still be completely at a loss to know what qualification of a particular proposition would make it a candidate for true generalization. We could never be sure that we had added the proper qualification. My test tubes may show me, for example, that hydrogen and oxygen follow Boyle's law; but further experiments will also show that *all* gases, including hydrogen and oxygen, follow Boyle's law only on the qualification that they remain within certain limits of temperature and pressure. But the principle of uniformity can not assure me that this *is* the one and necessary qualification upon which I can generalize the law. In terms of natural law the inductive principle becomes: every fact or event in experience exemplifies some natural law. What law? The principle leaves us in the dark. As applied to propositions about the non-empirical entities which enter into so many theories the principle would say: there is a structure underlying immediate experience which is its true structure. But what is this structure? Atoms? Or the *élan vital?* This question the principle leaves unanswered.

As an aid to inductive inference, the principle of uniformity is nothing more than a pious hope. We may consider it an expression of man's desire to rationalize experience, to find a sufficient reason from which the present fact will follow, to construct an explanatory theory. But the desire that there shall be a theory, law or generalization does not establish the truth of any theory, law or generalization. The principle may be, as has been suggested, simply a vast lie.[3] "Nature imprints in our minds," says a recent writer, "the conception of universal uniformity in order to blind us to the fact of the absolute incoherence of events—a fact which is obvious to everyone but a scientist."

Is there any other principle which will make it possible strictly to infer the truth of theories? Certainly we can not infer from the truth of the consequences of any proposition that the proposition, itself, is true without violating the principle of inference or formal logic. We can infer only that which is strictly implied, and a theory is not strictly implied by its consequences. It is indeed possible strictly to infer that a theory is false; this follows as a rigid deduction from the falsity of its consequences. But the truth of the theory can not be so reached from the true propositions upon which it is built.

It is impossible to assert that no principle of inductive inference which will assure the truth of propositions inferred by it *can be* discovered. But it can be said that no such principle has been discovered. Meanwhile, theories remain imaginative constructions whose truth lies beyond fact and logical inference.

The constructions of the theorist can be brought within the area of the true and the inferable only by enlarging the concepts of truth and inference. If truth means artistic truth, fidelity to the canons of good taste in theorizing, as truth in poetry is fidelity to standards of poetic beauty, a theory may then be called true when it exhibits the values of which we have spoken—elegance, utility, and explanatory value. But this is not the truth of every day experience, of prose and fact. It is the truth of fabrication and good artistry. So, also, if inference be freeing the mind to roam among possibilities and to choose the most fitting, theories are then inferred from their premises. But this is not the inference of strict logic with proceeds from true premises by implications to true conclusions.

Probability is often suggested as a substitute for truth in theories. Theories can, indeed, be said to have probability in a vague sense, where probability means scientific value in general—credibility, admissibility, a generic name for the values of which we have spoken. But a numerical probability calculated on an enumeration of cases of truth and falsity can scarcely be intended.

The conclusions of this brief study of theories are twofold. (1)

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[3] R. Demos, "Lies and Liars," *The Yale Review*, January, 1921, p. 382.

The chief value of a scientific construction is that it explains experience by making it a consequence of a deductive system. Explanatory value is sufficient to a theory; truth, in the sense of factual truth or inferred truth, is not established and is not a necessary value. Indeed, those qualities which make a theory a good explanation, generality and penetration beneath fact, are the very qualities which stand in the way of proving its truth. The proof of a theory is the proof of its general value as a scientific construction, and this is something other than its truth. (2) Further, there is no extraordinary type of logic which can be called inductive logic. The traditional distinction between induction and deduction is specious. To prove that a theory has scientific value is to make it the center of a deductive system the logical consequences of which ramify widely into experience. The processes involved do not differ from those by which any other logical system is built; rationalization in the physical sciences is of the same type as rationalization in the mathematical sciences. The intellectual interest in system-making is always an interest in deduction.

If there is any principle of induction it is this: free the imagination to build a deductive system which will yield the truths we know by experience. This is not a postulate of proof, but a counsel of action; and it would apply equally to those mathematical analyses which take their departure from commonly accepted mathematical truths. Human reason is of a single texture wherever its threads extend. The inductive and deductive methods coalesce.

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REVIEWS AND ABSTRACTS OF LITERATURE

The Group Mind. WILLIAM McDOUGALL. American Edition. New York: G. P. Putnam's Sons. 1920. Pp. xxii + 413.

This volume bears the sub-title, " A Sketch of the Principles of Collective Psychology with Some Attempt to Apply Them to the Interpretation of National Life and Character." Collective psychology has for its subject-matter the mental life of groups. It is, therefore, a part of the more general science of social psychology, which embraces both the mental life of groups and that of individuals in their social interactions. The author's previous work, *Introduction to Social Psychology,* he explains (p. 2), is not a treatise in social psychology but merely an introduction to it. In *The Introduction to Social Psychology* the author was merely laying the foundation for his social psychology, the first instalment of which has now